# ON A NEW (?) METHOD IN EXTERIOR BALLISTICS.[1]

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Whether the method to be described deserves to be called new or not is a matter of opinion, since the instrument here used was designed and built by one of us twenty-eight years ago, and has been described in an article in the *Physical Review,* Volume 6, May–June, 1898. The method of measuring time by means of the charging or discharging of a condenser has been used by Pouillet, and has been applied to ballistics by Cranz in Germany and Sabine in England, but so far as we know the electrometer has not been applied to ballistics.

The essential part of the instrument for measuring the time is shown in Fig. 1. A projectile drops from an electromagnet upon the two levers shown in the middle, the one on the right being carried on a carriage adjustable by means of a micrometer screw. By knowing the height through which the projectile falls, the velocity of the projectile on striking the lever is known.

The arrangement of the apparatus is shown in Fig. 2. The battery charges the condenser through a resistance, the condenser being short-circuited through conductor $(a, b)$, which in the calibration is the left hand lever of the drop interrupter. When the circuit is broken the condenser begins to charge in accordance with the equation

$$q = q_0(1 - e^{-\frac{t}{KR}}).$$

A curve of calibration is shown in Fig. 3, by which it appears that times may be measured of the order of one-millionth of a second.

In the ballistic application $(a, b)$ and $(c, d)$ are two strips of tin foil stretched tightly between the brass supports. These are shot

[1] Contribution from the Ballistic Institute, Clark University, No. 3.

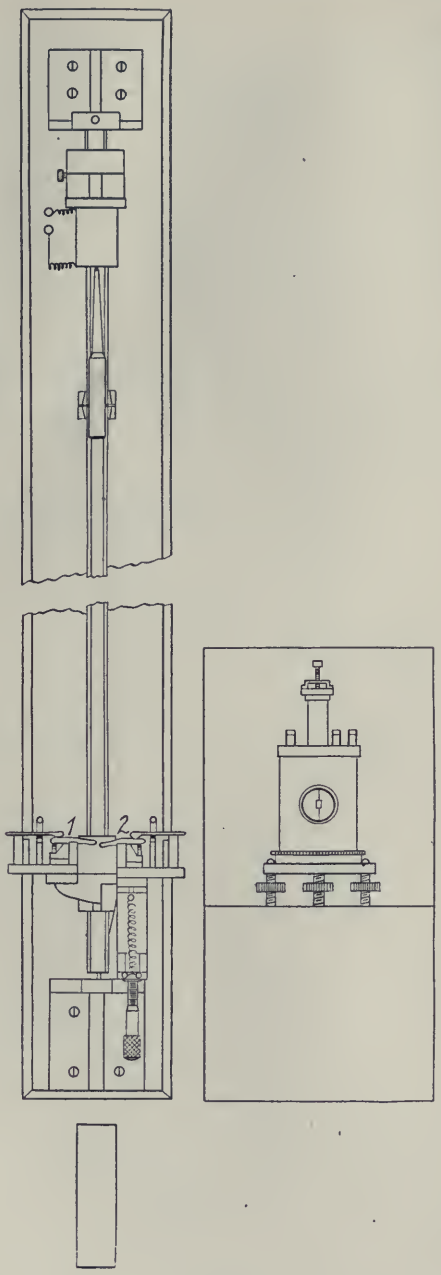


FIG. 1.

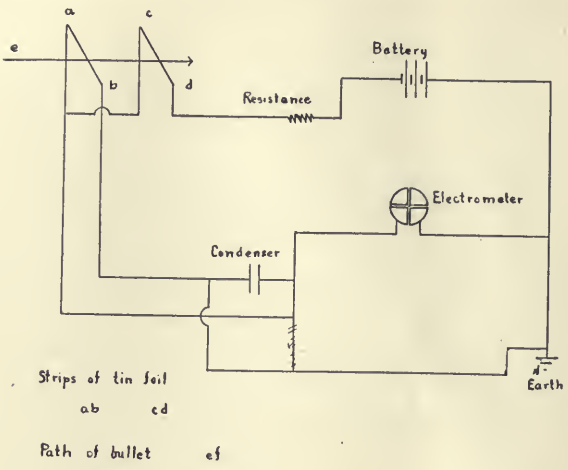
a
c
e
b
d
Battery
Resistance
Electrometer
Condenser
Earth
Strips of tin foil
ab cd
Path of bullet ef
Arrangement of apparatus
M. Allen

FIG. 2.

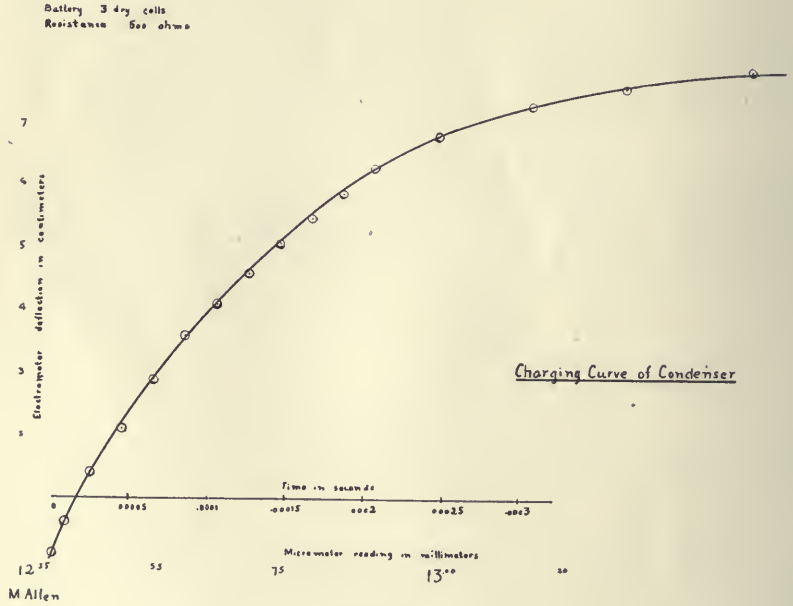
Battery 3 dry cells
Resistance 600 ohms
Electrometer deflection in centimeters
7
6
5
4
3
2
Time in seconds
0
.00005
.0001
.00015
.0002
.00025
.0003
Micrometer reading in millimeters
12.25
55
75
13.00
M Allen
Charging Curve of Condenser

FIG. 3.

away by a bullet. It is possible to measure the velocity of a bullet when the strips of tin foil are an inch apart, but in general a distance of two or three feet is conveniently taken. This may be contrasted with the distance of one hundred or one hundred and fifty feet generally used in ballistic laboratories of arms companies.

The table of results is given both for a small saloon rifle and for a .44 calibre gun. It is not claimed that this method would be of great use in the open, but in a laboratory it is certainly a very great convenience.

| Saloon Rifle. | | | .44 Calibre Rifle. |
|---|---|---|---|
| Deflection in Cms. | Time × 248 in Sec. | Velocity in Cms./Sec. | Velocity in Ft./Sec. |
| 5.2 | .037 | 30,162 | ——— |
| 5.4 | .039 | 28,615 | 1,303.0 |
| 5.3 | .038 | 29,368 | 1,330.2 |
| 5.3 | .038 | 29,368 | 1,329.2 |
| 5.3 | .038 | 29,368 | 1,326.4 |
| 5.3 | .038 | 29,368 | 1,284.0 |
| 5.3 | .038 | 29,368 | ——— |
| 5.4 | .039 | 28,615 | 1,375.7 |
| 5.4 | .039 | 28,615 | 1,327.3 |
| 5.1 | .036 | 31,000 | 1,326.4 |
| 5.5 | .041 | 25,363 | 1,339.8 |
| 5.4 | .039 | 28,615 | 1,320.7 |
| Average velocity ($v$) ..... | | 28,985 | 1,337.98 av. |